Ohio Agricultural Experiment Station.

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EXPERIMENTS WITH CORN.

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In this circular a brief report is given of tests of several varieties of corn conducted at this Station during the last three years; recent tests conducted at the Germantown and Carpenter test farms; results of different rates of seeding; methods of conducting ear-row tests at the Station and in our co-operative work, together with a few suggestions upon the selection of seed corn.

THE VARIETY TEST.

The variety test is conducted upon tenth-acre plots, every third plot being planted with a check variety. A yellow corn known as the Clarage, which has been grown by the Station for some 18 years, has been continuously used as the check. Duplicate plots are planted of most of the varieties tested and their average yield is reported.

In the following table, only those varieties are reported upon, which have been tested three successive seasons.

In determining the yield per acre each variety is compared with the check plots between which it grew, the number of bushels by which it exceeds, or falls short of the check determined and this excess or shortage added to or subtracted from the average yield of all the check plots.

The seasons of 1903 and 1904 were quite unfavorable to the corn crop in northeastern Ohio, being cold and wet and having unusually early frosts in the fall. Many of the different varieties were caught by the frost before they were mature, therefore the percent of shrinkage is notably high. This is determined by weighing 50 pounds of ear corn at husking, storing it in wire screen boxes until it is thoroughly air dry in March or April.

TABLE I.—VARIETY TESTS OF CORN. 1903—04.

VARIETY	Color of grain	Source of grain	Yield per acre (fall weight)	Yield per acre (air dry)	Percent of shrinkage	Percent of grain	Weight per shelled bushel	Number of ears in 100 lbs.	Stover per acre	Stover per bushel	Percent barren stalks
			Bus.	Bus.			Lbs.		Lbs.	Lbs.	
Boone County White	White	Ind.	72.85	48 30	33 7	81.2	48 7	94	4457	60 4	4 2
Boone County White	White	Tenn.	69.51	45 23	34.9	80 3	48.5	98	4297	62 6	7 7
Boone County Special	White	Ill.	59.11	39.84	32 6	81 1	47 0	111	3487	58 5	6.0
Darke County Mammoth	Yellow	Ohio	73 54	54.99	25.2	80.5	51.7	128	2975	40 3	3 9
Early Huron Dent	Yellow	Ohio	40.11	34 15	14.8	85.5	55 4	229	1452	36.1	1 7
Hardman Favorite	Yellow	Ohio	72,45	55.42	23.5	80.1	52.3	123	3260	45.0	3.8
Leaming	Yellow	Ohio	67.48	50 17	25.6	82 8	52.7	134	2776	42.7	2 7
Medina Pride	Yellow	Ohio	68,11	53 97	20.8	82.0	54.7	155	2487	36 5	1.5
Reid Yellow Dent	Yellow	Ill.	62 61	43 38	30.7	81.6	48.7	112	3541	56.1	6 7
Riley Favorite	Yellow	Ind.	64.22	48.16	25 0	83 3	50.0	133	3353	52 0	4 8
Selection No. 77. (U. S. D. A.)	White	Ohio	64 29	43 30	32.6	78 1	47 5	162	3852	59 9	3.1
Silver Mine	White	Ill.	58 82	39.61	32 6	81 9	48.2	140	2910	48 9	5 1
White Cap	Mixed	Ohio	52.40	44 01	16.0	84 2	55.2	164	2145	40 8	3 1
Clarage	Yellow	Ohio	51 46	41 15	20.0	82 3	55 5	157	2228	43.1	3.0
Average			62 64	45.83	26 3	81 8	51 1	139	3087	48 8	4 1

The weight of shelled corn is for the most part very low, showing the desirability of growing a variety of corn which will mature

In Table II is given a report of the same varieties as grown in 1905. The percent of shrinkage not having been determined yet, the weight at husking is all that can be reported upon. The yields per acre in 1905 are much larger than the previous year, the season having been quite favorable.

TABLE II.—VARIETY TEST OF CORN.—1905.

NAME OF VARIETY	Color of grain	Source of seed	Date of tasseling	Yield per acre (full weight)	Stover per acre	Stover per bushel
				Bus.	Lbs.	Lbs.
Boone County White	White	Ind.	July 29	95 35	7140	74 9
Boone County White	White	Tenn.	Aug. 3	104 54	7655	73.2
Boone County Special	White	Ill.	July 28	106.49	7320	68.7
Darke County Mammoth	Yellow	Ohio	" 23	104.99	5440	51 8
Early Huron Dent	Yellow	Ohio	" 18	73 85	4070	55 7
Hardman Favorite	Yellow	Ohio	" 22	102.98	5100	49.5
Leaming	Yellow	Ohio	" 23	106.44	5030	47 2
Medina Pride	Yellow	Ohio	" 19	95 19	4930	51.8
Reid Yellow Dent	Yellow	Ill.	" 29	100 87	6670	66 1
Riley Favorite	Yellow	Ind.	" 27	100 09	6285	62 8
Selection 77. (U. S. D. A.)	White	Ohio	" 30	109 88	8300	75 5
Silver Mine	White	Ill.	" 27	99.12	5980	60 3
White Cap	Mixed	Ohio	" 18	82.74	5060	61 1
Clarage	Yellow	Ohio	" 17	80.72	4604	57 0
Average				97.37	5970	61.1

The testing of varieties of corn has been begun at the test farms located at Germantown and Carpenter. The tables which follow represent, except as indicated, only one year's test.

The soil available for this work is not as uniform as that at Wooster; however, many of the plots have been duplicated and this will in part compensate the inequalities.

TABLE III.—VARIET CORN TEST AT GERMANTOWN.—1905.

VARIETY	Color of grain	Source of seed	Yield per acre (fall weight)	Stover per acre	Stover per bushel
			Bus.	Lbs.	Lbs
Boone County White*	White	Ind.	60.69	4465	72.9
Boone County White	White	Tenn	58 89	4460	75.7
Boone County Special	White	Ill.	58.95	3660	62 1
Cocke Prolific	White	Tenn.	61.20	6120	100.0
Darke County Mammoth*	Yellow	Ohio	64 99	3720	57.2
Hickory King	White	Tenn.	52.60	5650	107 4
Leaming*	Yellow	Ohio	63.38	3402	53 5
Marlboro Prolific	White	S. C.	55.03	5670	103 0
Mosby Prolific	White	Miss.	52.80	6840	129.5
Reid Yellow Dent*	Yellow	Ill.	61 55	4177	67 6
Riley Favorite	Yellow	Ind.	47.60	2950	61.9
Sanders Improved	White	Ga.	50.90	5680	111 6
Selby 136	Mixed	Ohio	51.56	3220	62 4
Selby 205	Mixed	Ohio	45.65	2250	49.3
Selection 77. (U. S. D. A.)	White	Ohio	62.75	4310	68 7
Clarage	Yellow	Ohio	52.60	2804	54 5
Average			56 32	4336	77 3

*Average of the two seasons 1904—05.

TABLE IV.—VARIETY CORN TEST AT CARPENTER.—1905.

VARIETY	Color of grain	Source of seed	Yield per acre (fall weight)	Stover per acre	Stover per bushel
			Bus.	Lbs.	Lbs.
Boone County White	White	Ind.	47 79	2695	56 4
Boone County White	White	Tenn.	67 84	4740	69 9
Boone County Special	White	Ill.	68 16	3920	57.5
Daike County Mammoth	Yellow	Ohio	52 13	5570	106.8
Funks 90 Day	Yellow	Ill.	60 73	3480	57 3
Golden Ideal	Yellhw	Mich.	44 99	2300	51 1
Hildreth	Yellow	Kan.	58 69	6500	110 8
Leaming	Yellow	Ohio	53 43	2450	45.8
McAuley Yellow Dent	Yellow	Kan.	74.14*	5690	76 7
McMakin Gourd Seed	White	Tenn.	48 34	4440	91 8
Mosby Prolific	White	Miss.	40 39	7600	188 1
Riley Favorite	Yellow	Ind.	49.35	2910	58.9
Reid Yellow Dent	Yellow	Ill.	42 11	2950	70.0
Silver Mine	White	Ill.	58.89	3200	54.3
Selby 136	Mixed	Ohio	43.24	2605	60.2
Selby 175	Yellow	Ohio	40 85	2 95	51.3
Selection No. 77. (U. S. D. A.)	White	Ohio	57.09	3945	69 1
Sturgis Hybrid	Yellow	Conn.	47.79	3500	73 2
Sanders Improved	White	Ga.	52 09	6160	118 2
Clarage	Yellow	Ohio	43 49	2164	49 7
Average			52 58	3946	75 9

*A very late variety and not as well cured out at husking as the others.

It is evident that many of the above varieties are not adapted to Ohio conditions. They have been included in these tests in co-operation with the National Department of Agriculture, in order that studies may be made of widely varying types of corn under equally varying environment, similar tests being carried on in co-operation with other experiment stations.

TABLE V.—THICK AND THIN SEEDING.—1904—05.

Number of plants per hill	Total yield per acre	Nubbins per acre	Average weight of ears	Percent of barren stalks	Percent of stalks with 2 ears	Stover per acre	Stover per bushel of grain
	Bus.	Bus.	Lbs.			Lbs.	Lbs.
1	37.54	2.2	.633	3.0	16.2	2165	57.6
2	63.51	5.7	.639	2.6	3.9	3030	47.7
2.89	78.34	5.7	.588	4.0	2.9	4025	51.3
3.62	87.13	8.2	.537	5.0	0.9	4317	49.5
4.18	86 48	10.6	480	9.4	0 6	4695	54.3

THICK AND THIN SEEDING.

Table V gives the results of two years of different rates of seeding, ranging from one plant per hill to a fraction over four. The planting has been in hills 42 inches apart each way. The ground was in good condition, having had an application of ten tons of stable manure per acre.

Owing to the failure of the corn planter to drop seed on the heavier seeded plots as wanted, they could not be thinned to quite the stand planned; this however, does not interfere with the value of the test.

The increase in yield is very pronounced up to an average stand of 3.62 plants per hill, but is accompanied by a decline in average weight per ear, which is especially marked as the seeding exceeds three plants per hill. It would seem that land which is in a high state of fertility would require an average stand of three plants per hill for a maximum crop, although thinner planting will give ears of larger average size.

While the yield of stover per acre increases from one plant per hill to four it does not bear a uniform relation to the grain. Since we find by far the largest percent of stalks having two ears when there is one plant per hill it may seem strange that the proportion of stover to grain is greatest here. This fact is due to the very large number of "suckers" in this thin planting. Nature is endeavoring to make a normal stand. In the absence of seed grain tillering is the only recourse and but few of the tillers bear ears.

CONDITION IN THE STATE AT LARGE.

In the light of experiments conducted by other stations of the corn belt, as well as our own, it would seem to be a reasonable assumption that three plants per hill, 42 inches apart each way, or its equivalent, if corn be drilled, is what might be termed a "normal stand" for Ohio under good conditions of fertility.

The stand of corn in Ohio for 1905, as gathered from field counts in 63 counties, made by 328 correspondents of our Department of Co-operative Experiments, would appear to be 83.6 percent of a normal stand. This is not a bad showing. It is probable, however, that the above mentioned correspondents represent conditions considerably above the average of the state. Be this as it may, counts from a number of the correspondents report less than 150 plants per 100 hills, and three county averages run from 157 to 181.

Enough is known to justify the statement that the average yield of Ohio might be increased 8 to 10 bushels per acre by better stands alone. The essentials in securing a perfect stand are two: --seed that will grow and correct planting. To insure the former an individual germination test should be made of each ear intended for seed. Our Department of Co-operative Experiments will be glad to assist any one desiring to work with us in conducting such germination tests. To insure correct planting, seed must be graded as to size, and the planter adjusted to size of kernel.

THE EAR-ROW TEST.

In the light of its own experience, and the more extended work of other plant breeders, this Station believes that permanent and valuable improvement in corn depends upon finding and taking complete advantage of the variation existing in individual corn plants,

as to their ability to produce bushels of corn per acre. Prof. Hansen, of South Dakota, has said that "there are Shakespeares in every species." The object in conducting the ear-row test is to find the Shakespeares in our corn fields, This test consists in comparing the *relative* productiveness of a number of ears of corn, planted side by side, an ear (or a part of an ear) to a row. Ears for such tests may well be selected while ripening in the field, in order that conditions of growth may be noted, and only such ears chosen as give some reasons for believing that their excellence may be due to something other than favorable environment.

After the ears have passed the germination test, data should be recorded, showing weight of ear, weight of cob, length of ear, circumference of ear and cob two inches from butt and tip, number of rows at butt and tip, number of kernels per row, depth of furrows between rows, average length of kernel, indentation, comparative size of germ, filling of tip and percent of protein.

As a part of the permanent record each ear going into the test should be photographed. This may be done after two rows of kernels have been removed for their nitrogen determination, and the ear so posed as to show something of the depth of kernel.

Ear-row test-plots may be planted without regard to other corn fields. The most convenient place frequently is at the end of a large corn field. Great care should be taken that the soil is of uniform fertility; that it has uniform treatment in every particular; that it is level, or of uniform slope, and that underdrains, back furrows, dead furrows and surface ditches affect each row alike.

The ears are planted in duplicate. A 50-hill row is planted from each ear in regular order, as previously numbered. At the completion of the first series an exact duplicate is planted, ear No. 1 in the second series following (save for the check row between them) the last ear of the first series.

The necessity for having a perfect stand makes liberal planting of seed important—5 kernels per hill is advised, to be thinned when corn is 6 to 8 inches high to 150 plants per row.

In addition to the check which one series of rows has upon the other, the Station is using a uniform check row, which is planted in the ear-row test-plot after every fifth row. The plot will, of course, begin and end with a check row as well.

The value of these check rows will depend upon their uniformity. Each must be planted from the same ears and each ear used in planting the check rows must have equal representation upon each check row. The ears needed to plant them are shelled and kept separate, and the same number of hills are planted from each of these ears upon each row.

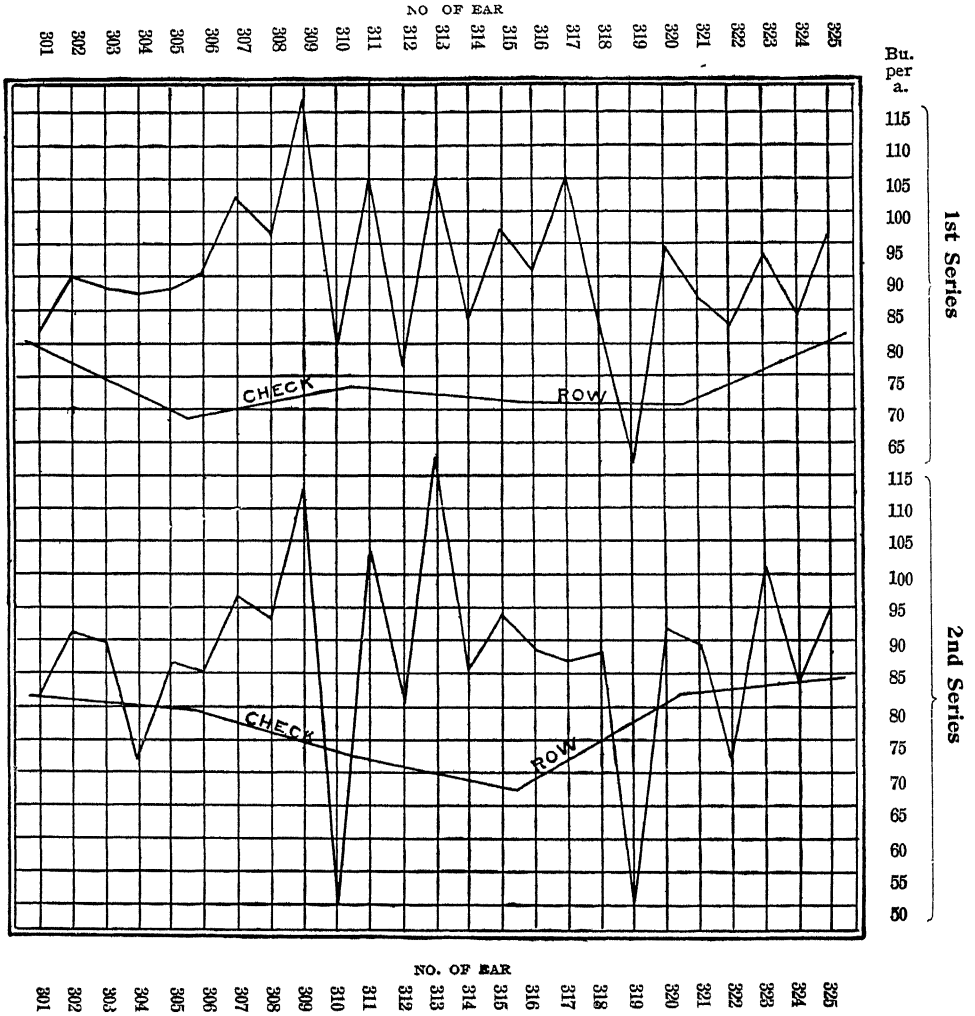
The check row performs the same service in correcting the yields in the ear-row work that the check plot does in the variety test previously mentioned. The method of determining the yield is the same in each case.

After the plants are all up, counts are made of the number of plants per row, previous to thinning. Notes are taken upon the comparative earliness of growth of each row, date of tasseling and silking, height of plants and ears, number of smut masses, number of plants with two or more ears, number of useless (barren, etc.) plants, and total number of plants at harvest.

Each row is cut, shocked and, when cured out, husked separately, the number of ears and nubbins and the weight of each being determined.

The total yields of each row of a duplicate ear-row test conducted at the Station in 1905 are shown by the following diagram:

Ear-row Test Plot.



The upper irregular line ("curve") shows the yields of the 25 tested ears as grown in the first series. The line immediately under this, marked "check row", shows the comparative yield of the 6 check rows planted in this series.

The lower curve shows the yields of the same ears in the duplicate or second series, with the check row cutting across it.

The slight variation in the yield of check rows, when compared with the variation in yield of the individual ears, would seem to leave little room to doubt that certain ears have proved their ability to produce much more corn than other ears of this test. For, bear in mind that the check rows are six times as far apart as the other rows and variation in yield which was due to differences in soil would be expected to be greater. A comparison of the two curves will convince one that these ears have behaved very much the same in each series. The marked exceptions to this are ears 304 and 317. Merging both curves in one, ears 309, 313 and 311 are clearly much superior to the others, with 307 as fourth in yield. Ears 310 and 319 clearly belong to the other extreme.

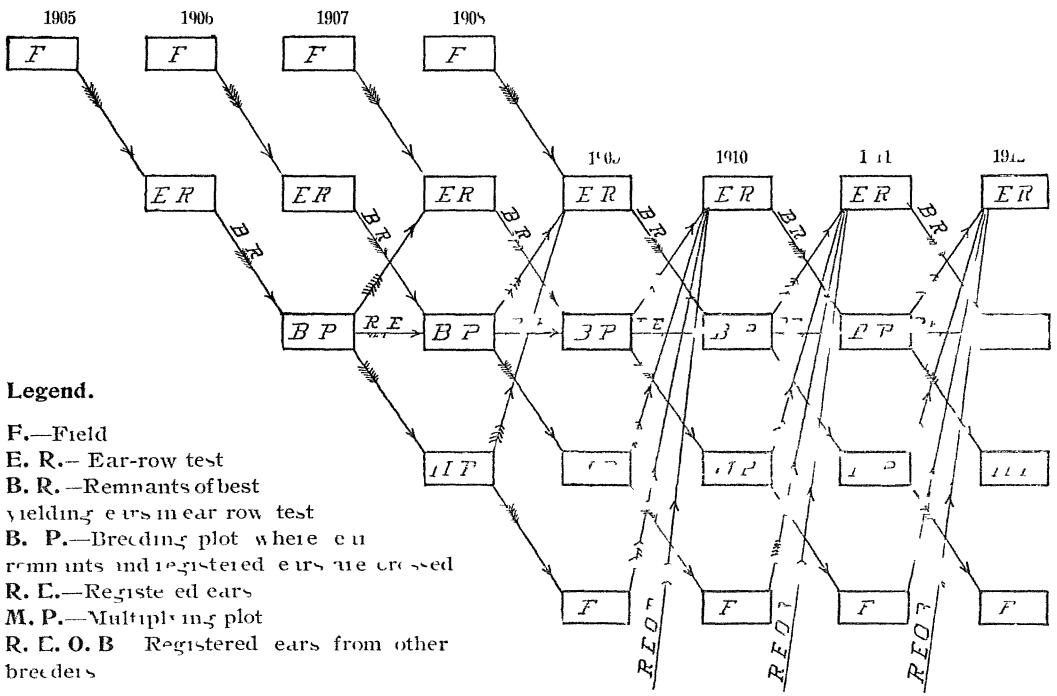
While the yields of each ear are indicated in bushels per acre, let it be understood that this is done in order that comparisons may be made more easily. It is the *comparative standing* of the ears tested that is of moment. Actual yields depend upon environment and go and come accordingly; comparative yields depend upon heredity.

Portions of each ear planted in our ear-row test plots are held in reserve, and such as are found to be superior, serve the following season as foundation stocks, from which to breed improved strains. The original remnants of ears 309, 313, 311 and 307 will be thus used.

A word further in regard to the above methods of checking:—it will not do to assume that the variation in yield of a given ear in the two series is due entirely to environment, for undoubtedly there is some variation in the different kernels from the same ear, since it is probable that several sires are represented on each ear. There is, however, great uniformity in the progeny of a single ear.

Neither can such assumption be made for the check row. Probably more uniform check rows could be had from the use of ears produced by hand pollination.

Diagram showing plan for corn breeding work.



Legend.

F.—Field
E. R.— Ear-row test
B. R.—Remnants of best yielding ears in ear row test
B. P.—Breeding plot where ear remnants and registered ears are crossed
R. E.—Registered ears
M. P.—Multiplying plot
R. E. O. B Registered ears from other breeders

THE SELECTION OF SEED CORN.

Yield of shelled corn per acre is and probably always will be the principal aim of the corn grower. Among the things which contribute to this end is choice seed. In selecting corn for seed the tendency undoubtedly is to place too much emphasis upon the appearance of the ear, especially upon shape, the covering of the ends, percent of grain—things which the actual ear-row tests do not show to be of great significance. While the ear-row test will be more and more appealed to in picking out high yielding ears, in connection with these tests, as well as in their absence, the corn grower has to pass judgment upon ears for use as seed. The ordinary score card is not of great service to him, for it has been arranged for use in corn shows without any reference to the growing plant. In the selection of seed corn the plant, as well as the conditions under which it is growing, has need to be considered. In other words, the selection of seed corn can be made most advantageously in the field.

In all plant breeding, in which yield is the principal object of selection, nothing is so important as a knowledge of the environment. Large, fully matured ears of corn are desirable for seed use, providing the excellence is due to inheritance; but they have little or no superiority if that excellence be due simply to environment: that is, to thin stand, extra normal feeding, etc.

The following score card is suggested for use in the field as a guide in selecting productive seed.

SCORE CARD FOR DENT CORN.

FOR USE IN FIELD.

Points.	Perfect score.
1—Vigor of plant	20
2—Position of ear	5
3—Weight of ear	50
4—Length of ear	5
5—Uniformity of plant and ear	10
6—Shape of kernel and size of germ	10

NOTES.

DISQUALIFICATIONS: Plants growing under less than normal stand; plants lying upon the ground or badly broken; plants diseased; plants maturing too late or too early and, in growing corn for other than feeding purposes, ears of mixed color in cob or grain.

VIGOR OF PLANT: Shown by circumference of stalk below ear; by uprightness; by leaf development and freedom from disease.

POSITION OF EAR: Such as not to pull too heavily upon the plant, nor make difficult husking in standing corn, nor interfere with the successful use of the corn harvester. Other things being equal, it is of advantage that the ear point downward at tip.

WEIGHT OF EAR: To be determined by use of scales when ear is thoroughly air-dry.

When the environment is known to be uniform as to stand and fertility, weight of ear is the all important thing, but apart from the corn field, with environment unknown, it is not as significant, although still of importance. Ear-row tests thus far have shown that total weight of ear is a little better guide to the productiveness of a seed ear than weight of shelled corn. Percent of grain has not proved important.

LENGTH OF EAR: When ears of equal weight differ in length and circumference, a slight premium should be placed upon length.

UNIFORMITY OF PLANT AND EAR: Uniformity as to habits of growth and vigor of plant, as well as to size, shape, color and indentation of ear are desirable. In the attempt to improve plants by selection the attainment of one's ideal will depend in no small part upon the uniformity of his selections.

SHAPE OF KERNEL AND SIZE OF GERM: Kernels should broaden gradually from tip to crown, with edges straight so that they touch the full length, and should be wedge-shaped without coming to a point. They should be full and plump at the tip. Observed from the edge they should have uniform thickness. Thin, shrunken, sharp-pointed kernels are very objectionable.

A large germ is indicative of high food value and vigor of growth.